(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 November 2002 (07.11.2002)

PCT

(10) International Publication Number
WO 02/087782 A1

(51) International Patent Classification[7]: B05C 5/02, G02F 1/1337

(21) International Application Number: PCT/US02/10967

(22) International Filing Date: 9 April 2002 (09.04.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
01109053 9 April 2001 (09.04.2001) RU

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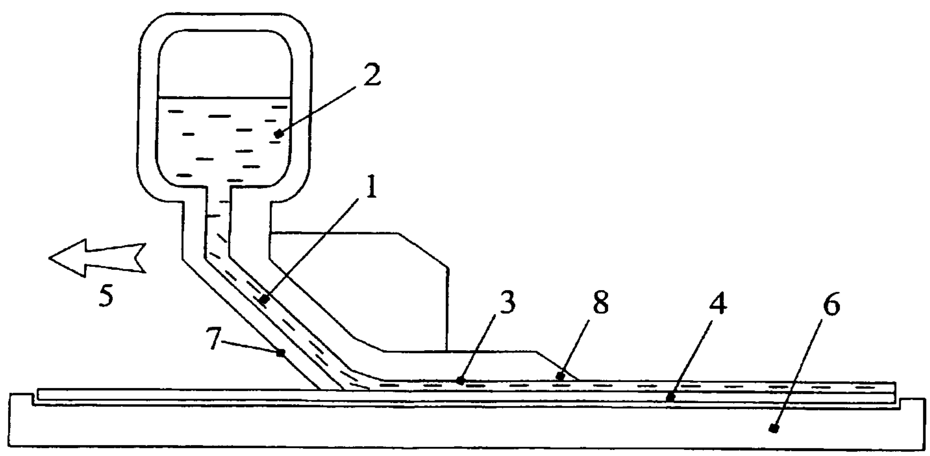
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

[Continued on next page]

(54) Title: DEVICE FOR FABRICATING ANISOTROPIC FILM



(57) Abstract: Invention pertains to technology of fabricating thin films or coatings, which possess anisotropic physical properties, and to devices for obtaining such films from colloid systems, in particular from lyotropic liquid crystals (LLP).Technical result of the herein disclosed invention is the design of a device for fabricating anisotropic films from colloid systems of organic or inorganic materials with anisometric particles, which would enhance perfection of the structure of the obtained films, enhance reproducibility of parameters over the entire surface of films, as well as throughout their thickness, and also enhance anisotropy of its properties. Device for fabricating films from a colloid system has a channel or an array of channels(1) for supplying colloid system onto the substrate or a ware,(4) and a flat facet (3) for acting on the colloid system while on the substrate or a ware(4). One of the channel's walls or a plane tangent to the walls of an array of channels (1)at the outlet of colloid system onto the substrate forms a obtuse dihedral angle with the flat facet, while the dihedral angle, which apex is at the edge of the flat facet (4)opposite to the outlet of the channel (1) is acute.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DEVICE FOR FABRICATING ANISOTROPIC FILM

Related Applications

This application claims priority to Russian Federation Application Serial No. RU 2001109053 filed April 9, 2001.

Field of the Invention

This invention relates to the fabrication of thin films or coatings, possessing anisotropy of physical properties, as well as to devices for fabricating such films out of colloid systems, in particular out of lyotropic liquid crystals (LLC).

Background Art

Currently widely used, particularly in fabrication of devices for presenting information, are optically anisotropic films obtained from LC solutions of organic dyes (See United States Patent Application Serial No. 09/720,227 filed April 2, 2001). Such films appear in the form of thin layers of molecularly ordered organic materials. Flat molecules of the mentioned materials are grouped into orientationally ordered aggregates – supramolecular complexes. The planes of molecules and their dipole moments of optical transition are oriented perpendicular to the axis of macroscopic orientation of the obtained film. To create such a structure one uses liquid-crystalline condition of solution of an organic material, in particular a dye, where molecules already possess local orderliness while existing in one- or two-dimensional quasi-crystalline aggregates oriented relative to each other. During application of such a system onto the surface of a base and infliction of an external orienting action they assume macroscopic orientation, which in the process of drying not only remains preserved, but may also improve due to crystallization phenomenon. The polarization axis is then directed along the orienting action, coinciding with the direction of polarizer application. Peculiarities of structure of the herein films originate the necessity to design special means for their fabrication.

There are various known methods of forming the herein films and, correspondingly, various devices for their implementation [US 5 739 296]. For example, application of LC solution is performed using a draw slot or a rod; the latter may be of a knife-like or cylindrical type. Application of LC solution onto the substrate surface may be carried out with simultaneous orienting of the supramolecular complexes in a particular direction; drying process would conclude the formation of the herein films. However, the known devices do not allow obtaining reproducible parameters of films with high degree of anisotropy over the entire surface of films, which is due to disturbances (defects) of molecular structure and macroscopic non-homogeneities (technological defects) during its formation. This is first of all due to rheological properties of utilized LLC solution, as well as the shape and design of the applying and/or orienting device.

Summary of the Invention

The present invention provides a device for forming anisotropic films from colloid systems (in other terminology – colloid solutions), in particular optically anisotropic films from LLC organic dyes, with high degree of perfection of the structure (crystallinity) over the entire film's surface and significant reproducibility of results. The device makes use of a special shape of design elements (parts) for application and orienting action, and creating rheological conditions of film formation, which enhance the degree of perfection of the film's structure and its homogeneity.

The area of application of the herein device is not limited by formation of optically anisotropic films from LC solution of an organic dye. It may be used for other objects – colloid systems formed by anisometric particles. For example, some films, formed from inorganic lyotropic liquid crystals of iron oxohydroxide or vanadium oxide possess anisotropy of electric and magnetic properties.

Technical result of the herein invention is the development of a device for fabricating anisotropic films from colloid systems of organic or inorganic materials with anisodimetric particles, which enhances perfection of the structure of obtained films, enhance reproducibility of parameters over the film's surface as well as through out its thickness, and also enhances the anisotropy of its properties.

Technical result is achieved by the fact that the device for obtaining films from a colloid system has a channel or a number of channels for supplying the colloid system onto the substrate or a ware, and a flat facet to act on the colloid system on the substrate or a ware, one of the walls of the channel or a plane tangent to the walls of an array of channels at the outlet of the colloid system onto the substrate forms an obtuse dihedral angle, while the dihedral angle, which apex is at the edge of the flat facet opposite to the outlet of the channel is acute.

The device may also contain a channel (or channels), at least part of which has a straight portion formed by flat-parallel walls.

It is preferred, that in the device, the smallest traverse dimension of the channel's cross section in [cm] $H < 0.05* l / L$, where l – is the length of the flat-parallel portion of the channel in [cm], L –the smallest distance along the flat facet from the apex of the obtuse dihedral angle to the opposite edge of the flat facet (for at least one section of the device) in [cm].

It is preferred, that the distance between the flat facet for influencing the colloid system and the substrate does not exceed 20 μm.

It is preferred, that the obtuse dihedral angle be from 135° to 150°, while the dihedral angle having its apex at the edge of the flat facet opposite to the outlet of the channel be from 10° to 30°.

At least a part of the channel's (or channels') surface and/or flat facet may be implemented hydrophobic and/or hydrophilic and on at least a part of the channel's surface and/or the flat facet there may be a relief and/or a texture.

The device may also contain a means of heating and/or cooling.

The device may also contain a means of varying the width of channels and a means of solution supply.

The device may be implemented out of a metal, plastic, glass or other material, as well as their combination.

In the disclosed invention, the means of supplying solution on to the substrate and the orienting element are incorporated in a single device. The device has a possibility of translation relative to the substrate. This may be translation of the device itself relative to the substrate, or the substrate holder with the substrate relative to the device, or their simultaneous translation. It is preferred that dimension of the device in the direction perpendicular to the relative translation would cover the entire width of the forming film. The gap between the orienting part and the substrate, dimensions of the channel (or channels) supplying the solution, as well as the speed of movement of the device and the rate of solution supply are chosen as to provide laminar flow of solution onto the substrate and uniform influence on the solution layer on the substrate. Moreover, partial orientation of kinetic particles (elements of the dispersion phase) happens already during the flow of solution through the channel. Absence of turbulence while supplying solution onto the substrate and infliction of orienting action lowers the number of structural defects induced by disorientation.

The shape of the "tail part" of the device will be determined by absence of clots, excess of material, droplets, etc. in the forming layer and on its surface during relative translation of the device and the substrate.

Thickness of the formed film will be determined by the gap between the orienting part and the substrate, and solution concentration.

Brief Description of the Drawings

The essence of the invention is illustrated by the following drawings:

Fig.1 presents general schematic of the herein disclosed device.

Fig.2 presents the main geometric dimensions and parameters, which affect operation of the device and parameters of the forming film.

Description of the Preferred Embodiments

The device shown in Fig. 1 contains: channel (or an array of channels) 1 for supplying the dispersion system (liquid-crystalline solution of an organic or inorganic material) from reservoir 2, element 3 which provides an orienting action onto the dispersion system applied to the substrate 4. The means of orienting action appears as a flat surface, forming a gap with the substrate. It is preferred that there would be a relief or a texture on this flat surface, with orientation along direction 5 of the relative translation. In the process of operation of the device the substrate is placed on the substrate holder 6. The means of translation (not shown on the figure) provides relative movement of the substrate holder with

the substrate and the device. During operation, the front part 7 slides over the substrate, "laying down the solution", and thus, providing additional orientation and uniformity of influence on the forming layer. The "tail part" 8 of the device should form an acute angle with the substrate in order to avoid accumulations and non-uniform detachments of solution from the orienting part.

Fig. 2 presents the main geometric dimensions and parameters, which affect operation of the device and parameters of the forming film: H – the smallest traverse dimension of the channel's cross section; l – length of the flat-parallel portion of the channel; L – distance along the flat facet from the apex of the obtuse dihedral angle to the tail edge of the flat facet; h – the gap between the flat facet and the substrate; α - obtuse dihedral angle (the wall of the channel of the front part of the device 7 is at an angle 180° minus α to the substrate); β - acute dihedral angle in the "tail part" 8 of the device.

To form an optically anisotropic film (dichroic polarizer) from LC aqueous solution of sulfonated indanthrone, the following parameters of the device have been used: H = 0.1 cm, l = 5cm, h = 10mkm, L = 1.5cm, α = 145°, β = 20°. Dye concentration in the LLC was 7.0 wt.%. The speed of translation was chosen in the interval from 60 to 100 cm/min. After drying (extraction of the solvent) a film with thickness 0.3 – 0.4 μ has been obtained. Polarizer obtained by this method had optical characteristics 14 – 25% better than analogous one obtained using traditional methods of application (Mayer's rod).

Depending on solution viscosity and desired thickness of the film in each particular case one determines operating parameters of the device. These parameters are determined experimentally or calculated according to known algorithms.

We claim:

1. A device for fabricating films from a colloid system, comprising a channel or an array of channels for supplying the colloid system onto substrate or a ware, and a flat facet for acting on the colloid system while on the substrate or a ware,

wherein one of the walls of the channel or a plane tangent to walls of an array of channels at the outlet of the colloid system onto the substrate forms an obtuse dihedral angle, while the dihedral angle, which apex is the edge opposite to the outlet of the channel is acute.

2. The device according to claim 1, wherein at least a part of channel(s) has a straight portion formed by flat parallel walls.

3. The device according to any of the claims 1-2, wherein the smallest traverse dimension of the channel's cross section in [cm] $H < 0.05 * l / L$, where l – is the length of the flat-parallel portion of the channel in [cm], L –the smallest distance (for at least one part of the device) along the flat facet from the apex of the obtuse dihedral angle to the opposite edge of the flat facet in [cm].

4. The device according to any of the claims 1-3, wherein the distance between the flat facet for acting on the colloid system and the substrate does not exceed 20 micrometers.

5. The device according to any of the claims 1-4, wherein the obtuse dihedral angle is within the interval from 135° to 150°.

6. The device according to any of the claims 1-5, wherein the dihedral angle which apex is the edge of the flat facet opposite to the outlet of the channel is within the interval from 10° to 30°.

7. The device according to any of the claims 1-6, wherein at least a part of the channel's (or channels') surface and/or the flat facet is hydrophilic and/or hydrophobic.

8. The device according to any of the claims 1-7, wherein on at least a part of the channel's (or channels') surface and/or the flat facet there is a relief and/or a texture.

9. The device according to any of the claims 1-8, wherein there is a means of heating and/or cooling.

10. The device according to any of the claims 1-9, wherein it contains a means of varying the width of the channel.

11. The device according to any of the claims 1-10, wherein there is a means of supplying solution.

12. The device according to any of the claims 1-11, wherein it is implemented out of metal and/or plastic and/or glass.

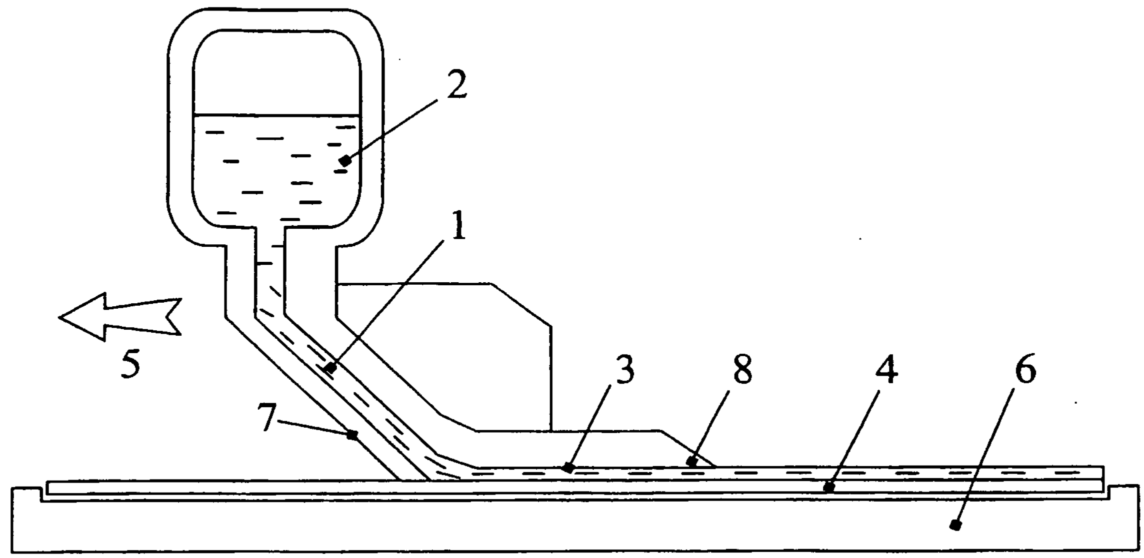

Fig.1

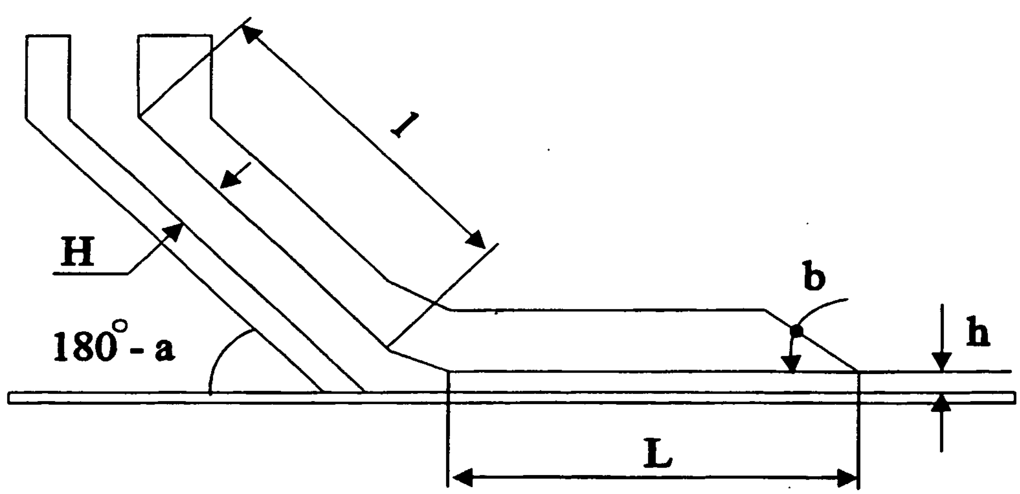

Fig.2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/10967

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B05C5/02 G02F1/1337

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B05C G02F G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 158 076 A (WALLSTEN HANS I) 12 June 1979 (1979-06-12) column 4, line 64 -column 5, line 10; figure 1	1
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 081 (C-0915), 27 February 1992 (1992-02-27) & JP 03 270761 A (HITACHI CHEM CO LTD), 2 December 1991 (1991-12-02) abstract	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 August 2002	23/08/2002

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 02/10967

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
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